INTRODUCTION

Over the past century, the historic range of Pacific salmon in the Pacific Northwest (PNW) has been reduced by nearly 50% (Nehlsen et al. 1991). The resulting reduction in salmonid abundance and diversity has led to the listing of several salmon stocks in the PNW under the Federal Endangered Species Act (ESA). There is no single cause for this decline, but significant contributors are human impacts on the aquatic ecosystems that support salmon populations (NRC 1996). Activities such as timber harvest, mining, agriculture, grazing, dams, fishing, hatcheries, and urbanization have all contributed to the "salmon problem." Urbanization (residential, commercial, and industrial) has been especially hard on small streams in the lowland ecoregions of the PNW (May et al. 1997). These small streams provide critical habitat for all freshwater life stages of salmonids (Williams et al. 1975).

The objective of the stream habitat assessment implemented by the City of Kirkland and King County in 2000 and described in this report was to quantify and assess the quality of the instream and riparian conditions that contribute to salmonid habitat. Stream habitat evaluation is a core element of several recently implemented regional programs. The Water Resource Inventory Area 8 (WRIA 8, Greater Lake Washington Watershed) technical committee is compiling stream habitat information as part of the salmon recovery planning process, which will result in identification of areas that require stream habitat restoration and preservation. The stream habitat assessment data discussed in this report have been incorporated into the "Salmon and Steelhead Habitat Limiting Factors. Water Resource Inventory Area 8" dated 2001 (Kerwin 2001). This report will provide information about Juanita Creek to benefit these and other projects and also supports other land use planning and Sensitive Areas regulation efforts.

Stream habitat loss and degradation are often cited as important limiting factors to salmon (Salo and Cundy 1987, Groot and Margolis 1991, Nehlsen et al. 1991, NRC 1996). High-quality rearing habitat is critical for the survival of juvenile salmonids from emergence to smolt migration. Adequate total pool area and depth along with sufficient hiding and thermal cover are necessary for successful salmonid rearing (Konopacky 1984, (Bjornn and Reiser 1991). Juvenile chinook, for example, use deep pools with good cover for freshwater rearing when they have emerged from stream gravels and before smoltification (Bjornn and Reiser 1991). Salmonids often shift their habitat preferences seasonally, primarily as a result of changes in flow and usable stream area. For example, juvenile coho prefer off-channel, backwater, or wetland pools during the winter, and show a preference for main-channel pools formed by large woody debris (LWD) in the summer months (Nawa et al. 1990, Nickelson et al. 1992, Peterson et al. 1992). In addition, adult chinook require deep staging or holding pools for their upstream migration and spawning (Giger 1973).

Human activities in the watershed can have detrimental effects on salmonid spawning habitat (Bisson et al. 1992). Pool frequency and quality decreases with increasing urbanization, in addition riffles tend to be replaced with glide habitat in channelized reaches (May 1997). Some studies indicate that the optimum pool to riffle ratio for salmonid production and over-winter survival is approximately 1:1 (Nickelson et al. 1992). On the other hand, Montgomery et al. (1999) found that chinook and coho redd frequency increased with decreasing pool spacing (i.e., increased pool frequency) in tributaries to the Skagit River. Streambed substrate is also critical to spawning success, incubation, and survival to emergence for salmonids. Each salmonid species has a specific preference for spawning habitat conditions (Kondolf and Wolman 1993), but all salmonids require spawning gravels that are highly permeable and well-oxygenated (McNeil 1966, Chapman 1988, Crisp and Carling 1989). Human activities in the watershed may contribute to sediment deposition in the interstitial spaces of spawning gravels by increasing over-land flow (including runoff) and stream bank erosion. This sediment may suffocate biota reliant on well-oxygenated intragravel flow (Hartman and Brown 1987).

Large woody debris performs numerous instream functions contributing to the formation of high quality aquatic habitat. Large woody debris is a key component for maintaining a high degree of habitat complexity and spatial heterogeneity in streams (Maser et al. 1988). In addition, LWD maintains the hydraulic stability of critical instream habitat features, especially pools (Bilby and Ward 1991). High-flow refuge for salmonids is provided by LWD, which dissipates hydraulic energy during peak flows (Bilby 1984). In addition, LWD stabilizes streambeds by minimizing scour and provides excellent cover and habitat diversity for salmonids (Harmon et al. 1986). If LWD is absent or scarce in the channel, stream morphology shifts away from the characteristic pool-riffle habitat to a more simplified, glide-dominant channel form, with a subsequent decrease in available pool rearing habitat.

Riparian forests play a critical role in the control of stream channel morphology because they stabilize the active floodplain and are the primary source of LWD. These "biophysical" interactions are particularly important to PNW stream ecosystems (Rot 1995). Riparian forest composition can determine the longevity and function of LWD in the channel. Large woody debris derived from conifers, especially western red cedar (*Thuja plicata),* tends to be larger than that from deciduous species, thus reducing the chance of being washed downstream. Large woody debris from conifers is also significantly more resistant to decay. This increased resistance results in increased longevity of instream structural components (Harmon et al. 1986). High riparian integrity is characterized by a large proportion of coniferous tree species, a wide buffer between the stream and any riparian development, and few spatial breaks (May and Horner 2000).

Modifications to natural land cover and the drainage network that result from urbanization change the hydrologic regime of the basin land-cover (Horner and May 1999) (Figure 1)). Under natural land-cover conditions in the PNW most stormwater infiltrates, and stormwater runoff is

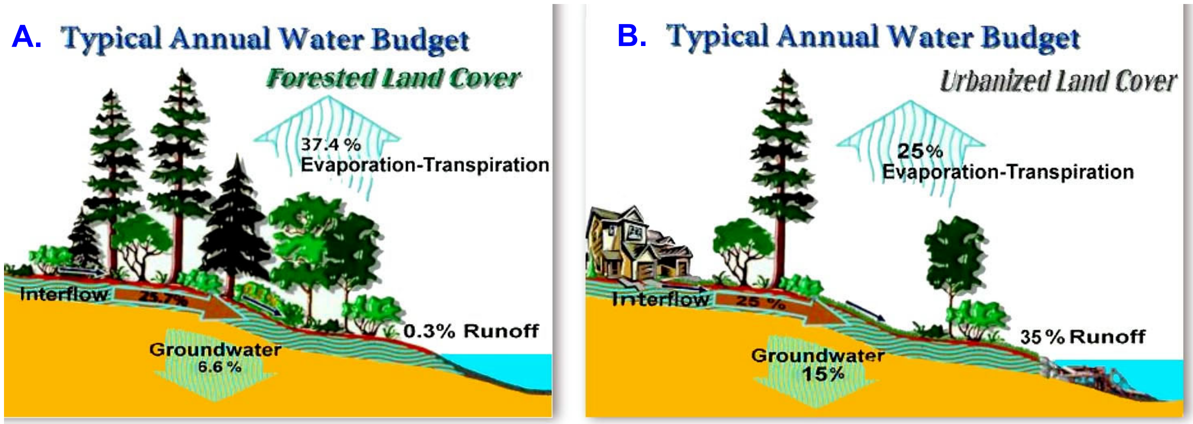

Figure 1. Typical annual water budget in watersheds with (A) forested land cover and (B) urbanized land-cover.

produced only during very large storm events (Booth 1991). As impervious surface increases with urbanization, the sub-surface dominated hydrologic regime created by stormwater infiltration shifts to one dominated by surface runoff. Urban development also adds numerous artificial channels to the natural stream system. The most common of these artificial channels are road-crossings (along with roadside drainage-ditches) that act as conduits for surface runoff and stormwater outfalls. Little or no infiltration or storage is associated with these artificial stormwater routing systems and as a result the runoff volume is dramatically increased.

In August of 2000, the City of Kirkland and King County conducted habitat assessments of Juanita Creek using the methods described herein. The goals of the habitat assessment project for Juanita Creek were threefold: (1) characterize instream and riparian habitat quality–primarily for salmonids; (2) establish a baseline for future evaluation of trends in habitat quality and watershed function; and (3) inform the process of prioritizing areas for restoration and preservation. This report describes how the City of Kirkland and King County characterized the stream and established baseline data for future monitoring projects and identification of priority restoration areas.

JUANITA CREEK

Juanita Creek is located within northeastern King County, Washington State. The Juanita Creek basin watershed covers approximately 6.6 mi^2 (17.14 km^2), and extends north to Simonds Road, south to NE 116th Street, east to 132nd NE, and west to 84th Avenue NE (Figure 4).

The climate and rainfall patterns in King County are typical of the Puget Sound Lowland (PSL) Ecoregion, with about 75% of the annual precipitation (average 38 inches annually) falling during the winter rainy season from October through April. Most precipitation is in the form of rain, with little snowfall.

The geology and soil structure of Juanita Creek Basin has been determined largely by the Vashon period of the Fraser glaciation about 15,000 years ago. The predominant surficial geology in the watershed is advance and recessional outwash deposits with some glacial till (King County 2001). The principal Soil Conservation Service (SCS) soil group within King County is classified as the Alderwood series (SCS hydrological soil group C), which is the most common soil type throughout the western part of the county. Hydrological soil group C is characterized by moderately high runoff potential (King County 1990).

The mainstem of Juanita Creek originates east of Interstate 405, and flows west and south entering the northeast end of Lake Washington on the west side of Juanita Beach Park. There are four main tributaries flowing into Juanita Creek: Simonds Tributary, (upper west), an unnamed lower west tributary, Totem Lake Tributary (lower east), and Tributary #238 (upper east). Areas around Juanita Creek are modified by residential and commercial development. From Juanita Drive to NE 124th Street, Juanita Creek flows through a highly developed urban area, containing multi-family housing developments and a professional center. From NE 124th Street to NE 132nd Street, Juanita Creek flows through both single and multi-family housing. Upstream of NE 132nd Street, the creek flows through the grounds of a psychiatric hospital, a rehabilitation clinic, and a school, as well as Edith Moulton Park, and single family housing.

The Simonds Tributary (upper west) to Juanita Creek joins the mainstem at NE 137th Place. The lower west tributary enters the mainstem of Juanita Creek from a culvert at NE 124th Street. This tributary is primarily made up of stormwater from single family housing, originating from a highly developed plateau further west (The Watershed Company 1998). Tributary #238 (upper east) originates north of NE 140th Street. It flows southwest to an in-stream pond near NE 132nd Street, then flows northwest and enters the mainstem of Juanita Creek near 108th Avenue NE. The Totem Lake Tributary (lower east) originates from Totem Lake, and flows through culverts under many roadways and Interstate 405. Downstream from Interstate 405, Totem Lake tributary flows through commercial businesses, Juanita High School, and a mix of single and multi-family residential housing, before entering the mainstem of Juanita Creek at a culvert outfall at 102nd Avenue NE and NE 129th Place.

The area was once almost completely forested with Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and red alder (*Alnus rubra*) (Franklin and Dyrness 1988). Repeated logging cycles beginning in the late-1800s, followed by residential and commercial development, especially since the mid-1960s, has reduced the forested land to a fraction of the original area (approximately 12%) (May, et al. 1997).

A 1956 review of conditions in Juanita Creek mentions that a few silver salmon (also called coho salmon, *Onchorhynchus kitsch*), silver trout (also called kokanee, *O. nerka),* and occasional cutthroat trout (*O. clarki)* are found in Juanita Creek (Ajwani 1956). In addition, in an overview of salmonid distribution in Washington streams, Williams (1975) noted that coho and sockeye salmon were found in Juanita Creek. In 2000, volunteer salmonwatchers observed small numbers of sockeye salmon and kokanee in the Juanita Creek basin (Vanderhoof 2001b).